Power supply for CD radio cassette players

BA3924

The BA3924 is a system reference power supply for use in CD radio cassette players. Outputs dedicated to a microprocessor (5.0V), CD player (7.5V), audio system (7.5V), and motor drive (9V) are built in. Also built in is a V_{CC}+B output that allows turning ON and OFF the supply voltage by HIGH and LOW levels of the standby pin.

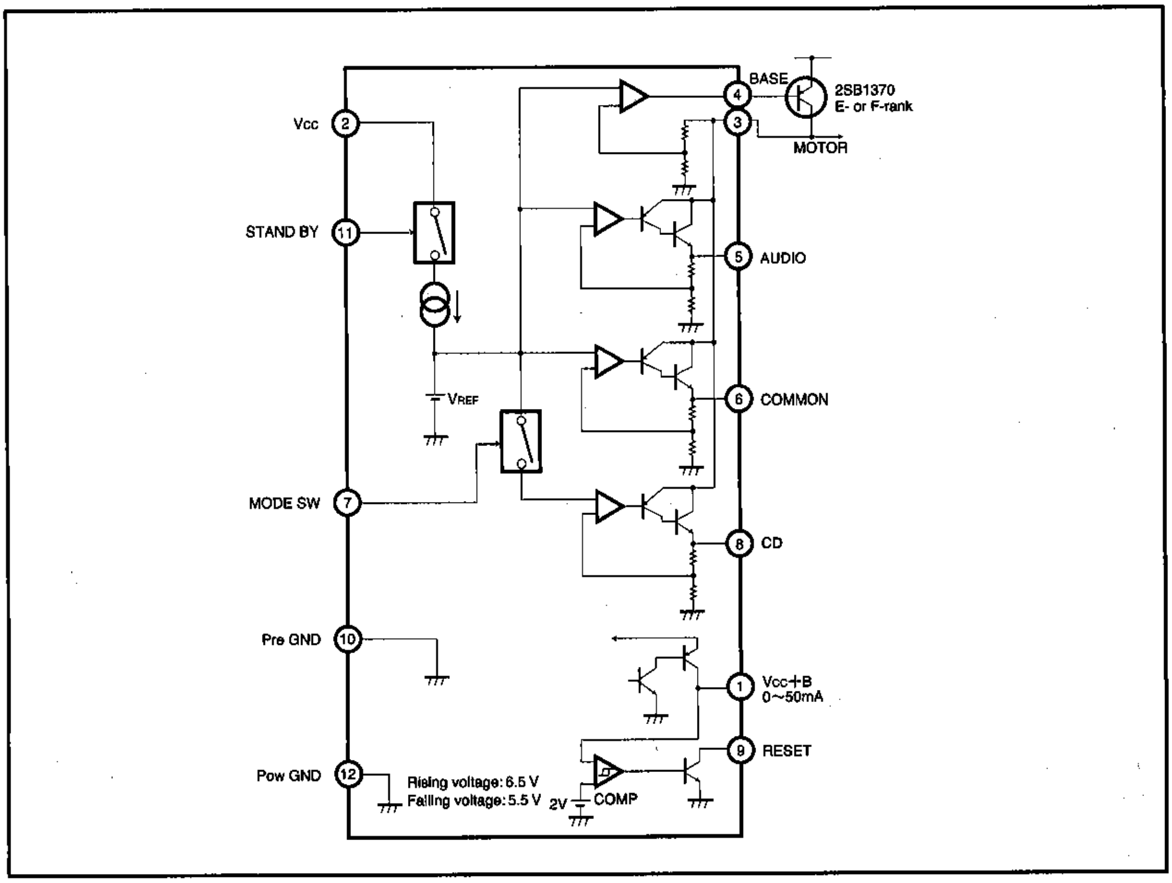
●Applications

CD radio cassette players

●Features

1) With outputs dedicated to a microcontroller, CD player, audio system, and motor drive, the IC is best suited for CD radio cassette players.
2) Zero standby current (typ.).
3) Output current limit circuit protects the IC against short-circuiting damage.
4) Compact 12-pin package allows large power dissipation.
5) Thermal shutdown circuit protects the IC against thermal damage.
6) V_{CC}+B output allows turning ON and OFF the supply voltage by HIGH and LOW levels of the standby pin.

●Block diagram



●Absolute maximum ratings (Ta=25℃)

Parameter	Symbol	Limits	Unit
Applied voltage	Vcc	22	V
Power dissipation	Pd	3000*1	mW
Operating temperature	Topr	−33~85	℃
Storage temperature	Tstg	−55~150	℃
Peak applied voltage	V_{surge}	30*2	V

*1 Reduce power by 24 mW for each degree above 25℃.
*2 200 ms (assured only during the standby state).

●Recommended operating conditions (Ta = 25℃)

Parameter	Symbol	Min.	Typ.	Max.	Unit
Power supply voltage*	Vcc	5.0	−	22.0	V

* Basic operation should be functional at Ta = 25℃.

●Electrical characteristics (unless otherwise noted, Ta=25°C, V_{CC}=12V)

Parameter	Symbol	Min.	Typ.	Max.	Unit	Conditions	Measurement Circuit
Standby circuit current	I_{ST}	–	0	5	μA	STANDBY pin = 0 V	Fig.5
Circuit current 1	I_{Q1}	–	20	43	mA	STANDBY pin = 5 V	Fig.5
Circuit current 2	I_{Q2}	–	60	110	mA	STANDBY pin = 5 V, V_{CC}= 8.5 V	Fig.5
Motor output voltage	V_{OMO}	8.5	9.0	9.5	V	Load current: 400 mA, external transistor: 2SB1370E	Fig.5
Base drive current	I_{BMO}	20	40	–	mA		Fig.6
Output-to-ground short-circuit current	I_{SM}	–	230	500	mA	Ground short-circuit: 0.1 Ω	Fig.5
Ripple rejection ratio	RR_M	–	50	–	dB	f=100Hz, V_{RR}=0dBm, I_{OM}=400mA	Fig.5
Audio output voltage	V_{O1}	7.1	7.5	7.9	V	I_{O1}=400mA	Fig.5
Voltage variation	ΔV_{O11}	–	20	±100	mV	V_{CC}=9~22V, I_{O1}=400mA	Fig.5
Load variation	ΔV_{O12}	–	50	±150	mV	I_{O1}=10~400mA	Fig.5
Minimum I/O voltage differential	ΔV_{O13}	–	1.05	1.25	V	I_{O1}=400mA, V_{CC}=8.0V	Fig.5
Output current capacity	I_{O1}	0	–	400	mA	V_{O1}≧7.1V	Fig.5
Output-to-ground short-circuit current	I_{S1}	–	200	350	mA	Ground short-circuit: 0.1 Ω	Fig.5
Ripple rejection ratio	RR_1	60	70	–	dB	f=100Hz, V_{RR}=0dBm, I_{O1}=400mA	Fig.5
CD output voltage	V_{O2}	7.1	7.5	7.9	V	I_{O2}=800mA	Fig.5
Voltage variation	ΔV_{O21}	–	20	±100	mV	V_{CC}=9~22V, I_{O2}=400mA	Fig.5
Load variation	ΔV_{O22}	–	50	±150	mV	I_{O2}=10~800mA	Fig.5
Minimum I/O voltage differential	ΔV_{O23}	–	1.05	1.25	V	I_{O2}=400mA, V_{CC}=8.0V	Fig.5
Output current capacity	I_{O2}	0	–	1	A	V_{O2}≧7.0V	Fig.5
Output-to-ground short-circuit current	I_{S2}	–	100	200	mA	Ground short-circuit: 0.1 Ω	Fig.5
Ripple rejection ratio	RR_2	50	60	–	dB	f=100Hz, V_{RR}=0dBm, I_{O2}=400mA	Fig.5
COMMON output voltage	ΔV_{O3}	4.7	5.0	5.3	V	I_{O3}=250mA	Fig.5
Voltage variation	ΔV_{O31}	–	20	±100	mV	V_{CC}=7~22V, I_{O3}=250mA	Fig.5
Load variation	ΔV_{O32}	–	40	±100	mV	I_{O3}=10~250mA	Fig.5
Minimum I/O voltage differential	ΔV_{O33}	–	1.2	1.6	V	I_{O3}=250mA, V_{CC}=5.0V	Fig.5

●Electrical characteristics

Parameter	Symbol	Min.	Typ.	Max.	Unit	Conditions	Measurement Circuit
Output current capacity	I_{O3}	0	–	250	mA	V_{O3}≧4.7V	Fig.5
Output-to-ground short-circuit current	I_{S3}	–	150	240	mA	Ground short-circuit: 0.1 Ω	Fig.5
Ripple rejection ratio	RR_3	60	70	–	dB	f=100Hz, V_{RR}=0dBm, I_{O3}=250mA	Fig.5
Vcc+B output voltage	V_{O4}	11.5	11.9	–	V	I_{O4}=35mA	Fig.5
Output current capacity 1	I_{O41}	0	–	50	mA	V_{O4}≧11.4V	Fig.5
Output current capacity 2	I_{O42}	0	–	50	mA	V_{O4}≧ 5.4 V when Vcc = 6.0 V	Fig.5
Reset output							
Sink current	I_S	0.5	3.5	–	mA	Vcc+B=5.0V	Fig.5
Vcc+B rising edge threshold	V_{TH1}	6.2	6.5	6.8	V	47 kΩ resistor is connected between the Reset and Vcc pins	Fig.5
Vcc+B falling edge threshold	V_{TH2}	5.2	5.5	5.8	V	47 kΩ resistor is connected between the Reset and Vcc pins	Fig.5
Input (MODE SW)							
CD output voltage OFF voltage	V_{THL1}	–	–	1.7	V		Fig.5
CD output voltage ON voltage	V_{TH2}	2.3	–	–	V		Fig.5
Input current 1 when HIGH	I_{IH1}	40	80	160	μA	MODE SW pin = 12 V	Fig.5
Input (STANDBY)							
IC standby voltage	V_{THL2}	–	–	0.4	V		Fig.5
IC operating voltage	V_{THH2}	1.2	–	–	V		Fig.5
Input current 2 when HIGH	I_{IH2}	–	25	50	μA	STAND.BY pin = 1.5 V	Fig.5
Temperature coefficient of each output voltage	ΔV_T	–	150	–	ppm /℃	V_{OMO}, V_{O1}, V_{O2}, V_{O3}, Ta=−30~85℃	Fig.5

1) STANDBY voltage is 0 V when measuring the standby circuit current and the STANDBY input; 5 V in all other cases.
2) MODE SW voltage is 5 V when measuring the CD output voltage (7.5 V) and its temperature coefficient; 0 V in all other cases.

●Electrical characteristic curves

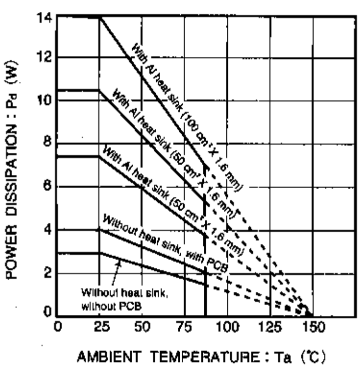


Fig.1 Thermal derating curves

● Measurement circuit

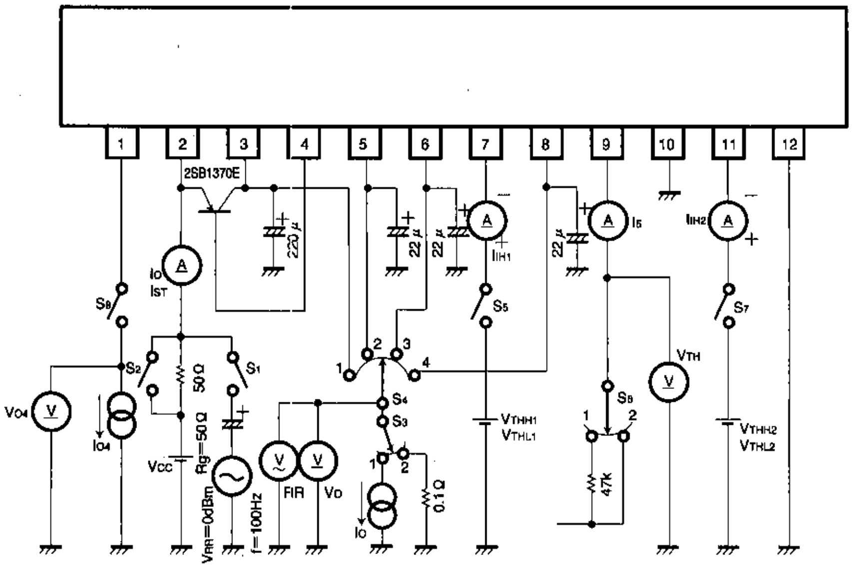


Fig.2

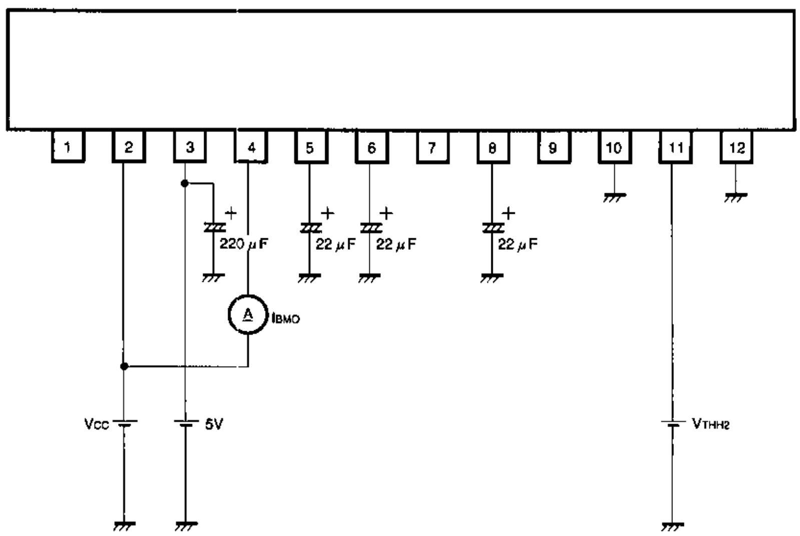


Fig.3

●Circuit operation

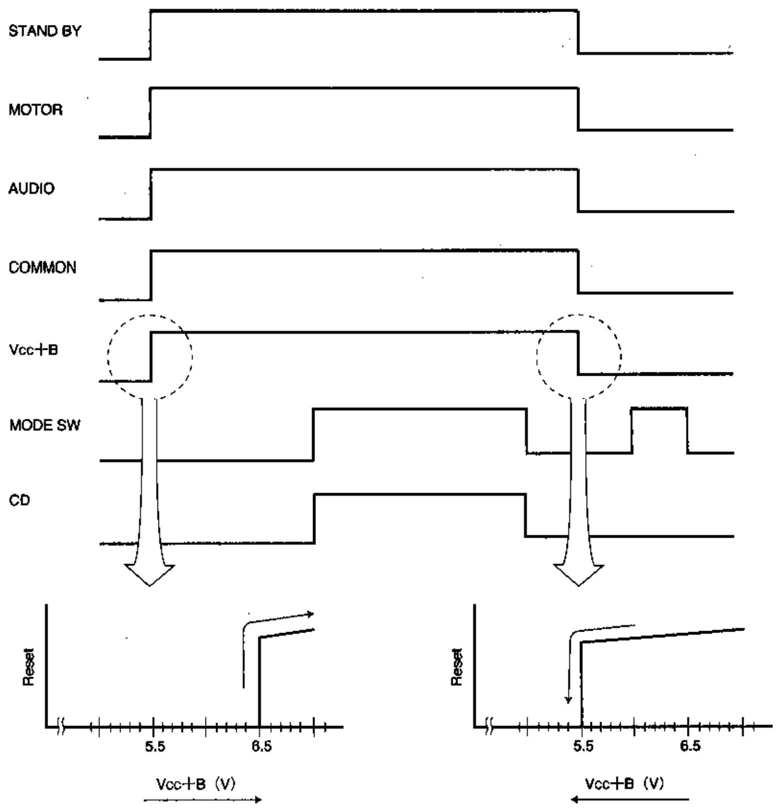
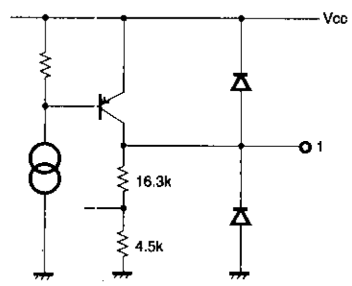
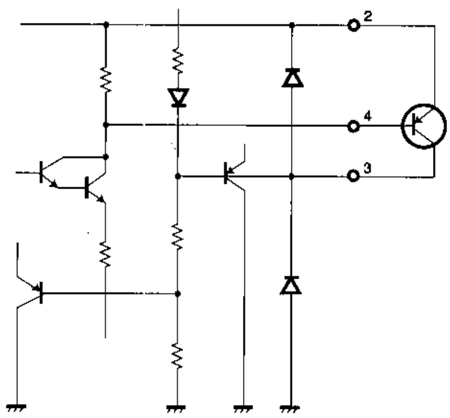
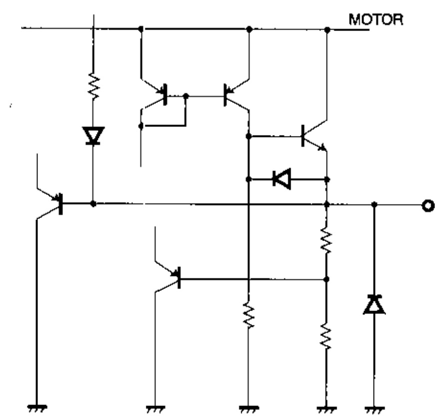
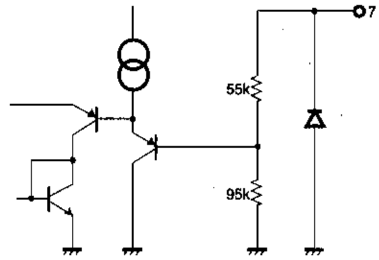
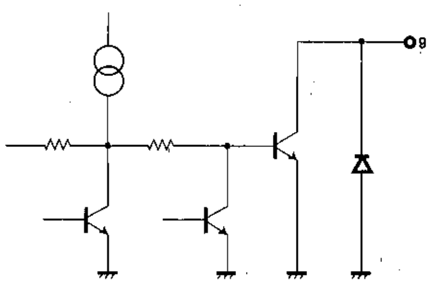
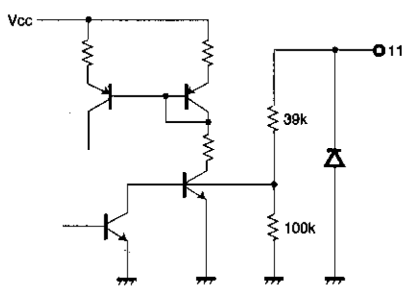


Fig.4

Note: ON/OFF of the Reset pin corresponds to the Vcc +B pin voltage. The above chart shows the hysteresis of signal rising and falling when a pull-up resistor is connected to the reset pin.

●Pin description

Pin name	Pin No.	Equivalent circuit	Function
Vcc+B	1pin		This pin has nearly the same potential as the supply voltage (Vcc). It can be connected to the power amplifier standby switch. Current capacity does not drop even during a voltage drop.
MOTOR BASE	3pin 4pin		This pin supplies voltage to a motor. 2SB1370 (E- or F-rank) is recommended for an external transistor: h_{FE} is 100-200 for E-rank and 160-320 for F-rank. Connect the external transistor as near as possible to the IC pin. A capacitor to prevent oscillation should be connected to the output pin.
AUDIO COMMON CD	5pin 6pin 8pin		AUDIO, COMMOM, and CD output pins. The currents in these circuits should be kept below the level of the allowable power dissipation. A capacitor to prevent oscillation should be connected to each output pin.

Pin name	Pin No.	Equivalent circuit	Function
MODE SW	7pin		The threshold is determined by the resistance ratio. Input impedance is k Ω (typical). The voltage to switch the CD output voltage is 2 V (typical).
RESET	9pin		Because this pin is an open collector output, connect a load resistor between this pin and the power supply. The ON/OFF of this output is determined by the rising and falling of the Vcc +B voltage.
STAND BY	11pin		ON/OFF switch of the IC
Vcc	2pin	This pin provides the supply voltage. The current supplied to the IC is comprised of the pre-drive current for the motor output current, the Vcc+B current, and the circuit current. If the trace from the smoothing circuit to the IC is rather long, connect a capacitor near the Vcc pin to suppress possible oscillation.	
Pre GND	10pin	This is the ground pin for minor currents at the reference power supply and each reference points. The pin is not connected to the IC substrate. If the potential of this pin is unstable, voltage and threshold values may shift.	
Pow GND	12pin	This is the ground pin for the circuit current and the pre-drive current of each power supply. Take sufficient care when designing the conductor pattern near the ground. The pin is connected to the IC substrate.	

●Operation notes

(1) Operating power supply

When operating within the proper ranges of power supply voltage and ambient temperature, most circuit functions are guaranteed. Although the rated values of electrical characteristics cannot be absolutely guaranteed, characteristic values do not change drastically within the proper ranges.

When the supply voltage becomes less than the sum of the minimum I/O voltage differential and each output voltage, the reference power supply will not function any more. However, there will be no sudden drop in voltage or output current.

(2) Power dissipation (Pd)

Refer to the power dissipation characteristics (Fig. 1) and the rough estimation of IC power dissipation given on a separate page. Make sure to consider the power dissipation of the external PNP transistors, through which power is supplied to the AUCIO, CD, and COMMON circuits. Leave a sufficient margin in your application.

・Power dissipation

Except under transitional conditions, the power dissipation of this IC is 3W per unit at 25℃. Use the following equations and Fig. 1 to roughly calculate the allowable power dissipation and decide if a heat sink is needed or what kind of a heat sink is needed.

(Basic equation)

$Pd = P - P_O$

where

P = power supplied from the power supply

P_O = power supplied to the load from the IC

(Rough estimation)

・Power consumed by the AUDIO output

$P_1 = (V_{OMO} - V_{O1}) \times I_{O1}$

・Power consumed by the CD output

$P_2 = (V_{OMO} - V_{O2}) \times I_{O2}$

・Power consumed by the COMMON output

$P_3 = (V_{OMO} - V_{O3}) \times I_{O3}$

・Power consumed by the V_{CC}+B output

$P_4 = (V_{CC} - V_{O4}) \times I_{O4}$

・Power consumed by the circuit current

$P_5 = V_{CC} \times I_O$

・Power consumed by the MOTOR output

where

$P_6 = (V_{CC} - V_F) \times I_{BMO}$

$Pd = P_1 + P_2 + P_3 + P_4 + P_5 + P_6$

V_{CC} is the maximum constant supply voltage

V_{OMO} is the minimum MOTOR output voltage

V_{O1} is the minimum AUDIO output voltage

V_{O2} is the minimum CD output voltage

V_{O3} is the minimum COMMON output voltage

V_{O4} is the minimum V_{CC}+B output voltage

$V_{CC} - V_F$ = (minimum constant supply voltage) − 0.7V

I_Q is the maximum circuit current

I_{O1} is the maximum AUDIO constant output current

I_{O2} is the maximum CD constant output current

I_{O3} is the maximum COMMON constant output current

I_{O4} is the maximum V_{CC}+B constant output current

I_{O5} is the maximum constant base drive current

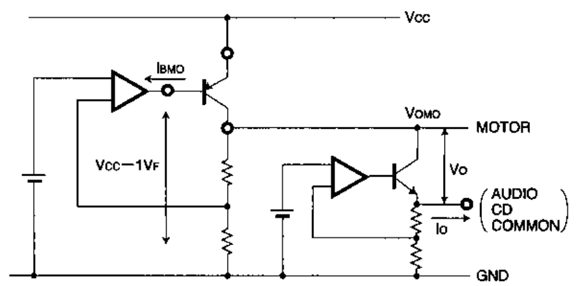


Fig.5

(3) Preventing oscillation at each output

To stop output oscillation, make sure to connect a capacitor between GND and each of the MOTOR (pin 3), AUDIO (pin 5), COMMON (pin 6), and CD (pin 8) output pins. Use capacitors whose capacitances are not below the values denoted in the application circuit (Fig. 7) and not susceptible to temperature.

(4) Ground pins

Pre GND (pin 10) and Pow GND (pin 12) are the ground pins of the IC. Pin 10 is the reference ground pin for power supplies, including the built-in reference power supply, and the comparators. Voltage and threshold values may shift if the potential of pin 10 is unstable. Take sufficient care when designing the conductor pattern near this pin. The source current from this pin is in the level of a few milliamperes. Pin 12, which is connected to the ground traces other than those connected to pin 10, is connected with the IC substrate and the back metal.

(5) External PNP transistors

ROHM's 2SB1370 (E- or F-rank) is recommended. This is a TO-220FP type transistor.

(6) Overvoltage protection circuit

Although the absolute maximum voltage is 22V, a peak voltage of 30V for 200ms is assured only during the standby state (pin 11 is LOW). The overvoltage circuit is activated when the V_{CC} voltage exceeds 23V. When the circuit is activated, a standby circuit current (IST) of a few milliamperes flows in the IC.

The overvoltage protection circuit is also activated if a voltage exceeding the absolute maximum rating is applied while the STANDBY pin is HIGH. As a result all the output voltage is turned off.

(7) Overcurrent protection circuit

If the output current of any of the MOTOR (pin 3), AUDIO (pin 5), COMMON (pin 6), and CD (pin 8) exceeds the current capacity, the built-in current limit circuit limits the current to a set level. If the potential of each pin is about the same as that of Pow GND (pin 12), the output current is reduced to the level of the ground short-circuit current given in the "Electrical Characteristics."

(8) Thermal protection

The circuit current, the limit current of each power supply output, and the ground short-circuit current decrease gradually with increasing temperature. For further protection, the thermal shutdown circuit turns off all outputs when the IC is overheated, and brings back to normal operation when the temperature is decreased to a certain level.

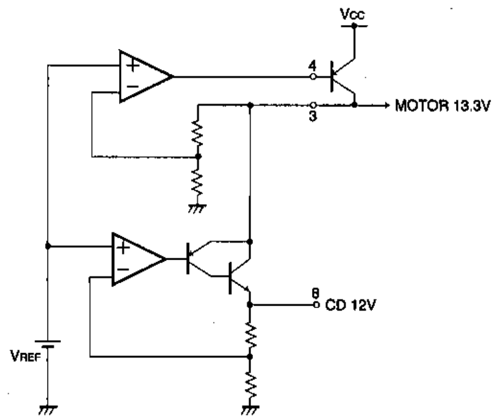


Fig.6

●Application example

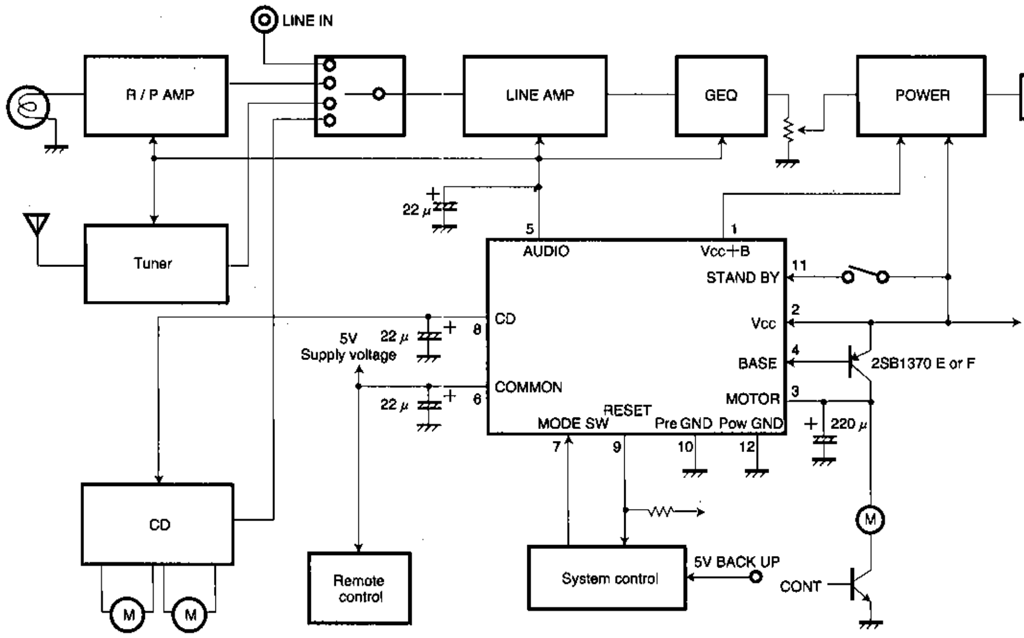


Fig.7

●External dimensions (Units: mm)

